

PREPRODUCTION INITIATIVE-NELP RADAR LIQUID COOLANT FILTRATION SYSTEM TEST PLAN

1.0 OBJECTIVE

The existing organizational-level (O-Level) liquid coolant filtration requirements for the F/A-18 are not being met by the current support equipment (SE) (*i.e.*, Dielectric Coolant Purification Cart, P/N 160195-1)—as made clear in the F/A-18 Action Number SC-9404-0004 dated 23 January 1995. Therefore, this technology demonstration will evaluate the pollution prevention and operational aspects of a new radar liquid coolant filtration system for use as O-level SE.

The Navy is currently phasing out Coolanol in favor of poly alpha olefin (PAO). The coolant servicing carts currently in use cannot handle PAO. This results in some coolant (*i.e.*, Coolanol) being serviced and some (*i.e.*, PAO) being flushed, purged, and disposed of as hazardous waste. The situation is more complex during the phaseout process because the coolant in the system is actually a mixture of both Coolanol and PAO. To extend the life of the radar coolant beyond a single use, a system is required that will service both Coolanol and PAO, as well as a mixture of the two.

This test plan describes the data collection procedure for the Mayhew Liquid Coolant Filtration Unit (LCFU), MHAC-2AC-302-8. The data will be used to determine the unit's efficiency, cost-effectiveness, and overall success. Specifically, the unit will be evaluated for its ability to:

- effectively service both Coolanol and PAO
- reduce the amount of hazardous waste requiring disposal
- reduce operating costs
- reduce the time associated with servicing the radar coolant.

2.0 DESCRIPTION

The LCFU (see Figure 1) is specifically designed to treat both Coolanol and PAO in the F/A-18 radar system. The LCFU pumps liquid coolant from the aircraft radar liquid coolant system (LCS) through the LCFU filtering and purifying system and back into the LCS in a closed-loop process. The LCFU contains desiccant and particle removal media to remove moisture and reduce the contaminant particle count to 5 microns. In addition to purifying the fluid, the LCFU compensates for fluid loss in the LCS, which eliminates the need for a separate fluid makeup unit (FMU).

The 250-pound LCFU is self-contained and mounted on casters for portability. It is 30" long x 30" wide x 30" high and has three metal filter canisters and one small door on top. The electrical installation requirements are 110 vac, 60 Hz, 1 phase, 15 amp.

3.0 TEST PLAN

Due to the technical nature of this prototype unit, quality assurance is essential. Once the quality of the treated coolant is determined to be acceptable for reuse, the unit will be evaluated based on financial return on investment, time savings, and environmental benefits.

The testing processes and procedures for this test plan will be applied to both the technical performance evaluation and the site operational data collection testing.

3.1 Special Instructions

Follow the special instructions in Sections 3.1.1 through 3.1.3 during the technical performance evaluation and the site operational data collection testing.

3.1.1 Electrical Grounding

The following procedures must be performed before electrical power is applied to the aircraft and/or the LCFU.

1. Properly ground the aircraft being serviced in accordance with standard operating procedures.
2. Ground the LCFU to the aircraft being serviced.

3.1.2 LCFU Operating and Maintenance Instructions

Perform operating and maintenance instructions in accordance with the Mayhew Industries, Inc., LCFU Operating and Maintenance Instructions Manual (U.S. Navy Contract Number #97121-EQ90).

Procedures for removing and refilling the F/A-18 radar coolant fluid sampling should be in accordance with the Maintenance Requirement Card (MRC), A1-F18AC-LMM-000, WP 035 00, Organizational Maintenance Procedures, Servicing Radar Liquid Cooling System.

3.1.3 Test Configuration

The LCFU test set interfaces with the aircraft radar LCS via quick disconnects. The LCFU directs fluid from the LCS through the filtering and purifying system and back into the LCS—thereby creating a closed loop. Fluid is taken from the LCS supply quick disconnect and returned through the LCS return quick disconnect. See Figure 2 for an illustration of this process.

3.2 Technical Performance Evaluation

The technical performance evaluation will take place at Point Mugu and China Lake. The LCFU will be evaluated for its ability to recondition and purify the liquid coolant in the F/A-18 radar system under test (SUT). The unit's effectiveness will be determined through particle count and moisture content. The pass/fail criteria were determined by the Navy Oil Analysis Program (NOAP) Laboratory at the Naval Aviation Depot North Island, San Diego, California.

3.2.1 LCFU Technical Performance Tests

1. Confirm that the LCFU will recondition contaminated PAO and Coolanol to acceptable levels of particulate and water.
2. Verify SE and fluid compatibility (*e.g.*, PAO/Coolanol does not harm the LCFU and vice versa).
3. Verify SE and radar compatibility.
4. Verify the LCFU manufacturer manuals.

3.2.2 Supply Equipment Required

The supply equipment required for the LCFU technical performance tests for reconditioning and purifying the liquid coolant in the F/A-18 Radar SUT is as follows:

- 20 gallons of PAO, NSN-9160-01-336-7174
- 4 dozen Sampling Pack coolant bottles, NSN-4935-01-131-9184
- Playtex gloves.

3.2.3 Pass/Fail Criteria

To be considered effective at reconditioning the radar coolant, the LCFU must meet the following criteria.

1. Water and particulate contamination in the PAO and Coolanol must be effectively removed according to current NOAP acceptance criteria for Coolanol SE, as per NA 17-15-50.2.1. These criteria are listed below.
 - Reduce particulate contamination from Navy Particulate Standard Class (NPSC) of greater than Class 5 to less than or equal to NPSC Class 3.
 - Reduce water contamination to a maximum of 100 ppm.
1. Fluid properties tested under the NOAP program (*e.g.*, volume resistivity, dielectric strength, and flash point) must not be adversely affected by the LCFU reconditioning process. As long as the required fluid properties are not affected, the reconditioned coolant should be adequate for reuse. The pass/fail criteria are called out in NAVAIRSYSCOM 411A4 #1213 dated November 30, 1978.
 - Volume resistivity (10 E 10 ohm/cm): 4 (minimum)
 - Dielectric breakdown (volts/mil): 300 (minimum)
 - Flash point (degrees Fahrenheit): 275 (minimum)
1. LCFU components must not be adversely affected by either PAO or Coolanol. Evidence of swelling, hardening, corrosion, or other undesirable effects on filters, tubing, seals, O-rings, or other LCFU components that will cause leakage or premature breakdown of the unit are not acceptable.
2. The LCFU contains the following necessary salient characteristics (*i.e.*, quick disconnects, pressure, flow rate, and safety features) to operate safely on radar systems (*i.e.*, F/A-18 radar):
 - Mating quick disconnect suitable for F/A-18
 - Pressure
 - 50 psi (maximum).
 - Pressure gage has adequate range and graduations to obtain accurate measurements.
 - Pressure control is not overly sensitive or insensitive (*i.e.*, easy to overshoot or undershoot pressure).
 - Either the system cannot generate enough pressure to harm the radar system or relief valves operate in such a manner.
 - Flow rate
 - 0 - 4 gpm.
 - Meets flowmeter range and accuracy.
 - Flow control is adequate.
 - Safety features
 - Grounding attachments.
 - Wheel locking mechanism.

3.2.4 *Technical Performance Evaluation Test Method*

1. By inspection or operation, verify whether the LCFU meets the minimum necessary requirements to hook up to an actual radar system.
2. LCFU coolant compatibility and LCFU reconditioning effectiveness will be determined by the following procedure.
 - a. Clean and purge/drain the LCFU according to the manufacturer's manual. To prevent cross fluid contamination, replace filters, seals, and other components in accordance with the manual or the manufacturer recommendations.
 - b. Visually inspect the LCFU's components and filters for comparison at the end of the test period. Photograph seals, filters, and other organic/synthetic materials that might be adversely affected by the coolant.
 - c. Obtain sufficient coolant (either all PAO or all Coolanol 25R) to operate the unit and create a sufficient volume of contaminated coolant to be cleaned. The volume of coolant to be contaminated should equal or exceed the volume of fluid in a typical radar system and should also provide makeup fluid for the volume of coolant removed for baseline and operational samples.
 - If new fluid is obtained:
 - Take a baseline sample from every container used to fill the unit.
 - Record the amount of fluid dispensed from each container and the associated baseline sample drawn from the unit.
 - If used fluid is obtained:
 - Verify that the coolant is certified to pass all NOAP test criteria.
 - Verify that adequate proof exists to confirm that the system is pure (*i.e.*, all PAO or all Coolanol 25R).
 - Mix the coolant in a clean container (or a container that previously contained the coolant being tested).
 - Take a baseline sample.
 - a. Fill up the LCFU with the new or used fluid.
 - b. Use the remaining fluid to prepare a batch of contaminated coolant. Contaminate the coolant with water and particulate to the following levels:
 - Particulate: > Class 5 NPSC
 - Water: > 200 ppm.
 - a. After agitating the batch of contaminated coolant, take a baseline sample.

- b. Attach the LCFU to the container of contaminated fluid and turn on the LCFU. If necessary, use a mixer to keep the coolant from stagnating and allowing the particulate or water to settle out.
- c. To determine how long the unit takes to clean the fluid, take samples for full NOAP analysis after 15 minutes, 30 minutes, 1 hour, 1.5 hours, 2 hours, and 3 hours. If possible, draw the sample from the inlet side of the LCFU. If necessary, draw samples from the container reservoir or downstream of the LCFU.
- d. To determine whether the LCFU is harming the coolant's properties, draw samples of the coolant every additional 3 or 4 hours until the unit has been operating for at least 24 hours.
- e. Drain coolant from the LCFU into a clean container or a container that previously held the same coolant. This coolant may be used or analyzed later, if needed.
- f. Examine filters, seals, and other components of the LCFU. Photograph and/or record any degradation of the material. End the test if severe degradation is noted.
- g. Send samples for full NOAP testing on particulate, water, flash point, volume resistivity, and dielectric breakdown tests.

3. Repeat the above test for other coolants.

3.2.5 Data Collection for Technical Performance Testing

Complete Table 1 with the data acquired from the technical performance testing. Entries will be handled the same for both PAO and Coolanol.

3.2.5.1 Instructions for Completing Table 1

1. LCFU and Radar System Compatibility

- Proper quick disconnect: Indicate whether the quick disconnect is appropriate for the SUT.
- Pressure range: Indicate whether the appropriate pressure range was achieved and maintained.

2. LCFU and Coolant Compatibility

- Sample data: Record the sample parameters regarding the test setup.
- NOAP Results: Record the results of the NOAP analysis on the chart. Data will include:

- Sample description
 - Actual time taken
 - Particulate class
 - Water (ppm)
 - Flash point
 - Volume resistivity
 - Dielectric strength.
- Pre- and post-test inspection: Discuss any damages or degradation encountered during the testing process.

3.3 Site Operation Data Collection

Site operation data will be collected to evaluate the environmental benefits and labor and cost savings for the Pollution Prevention Equipment Program (PPEP). Operational data will be reviewed in a cost/benefit framework via indicators such as net present value, internal rate of return, and payback period.

3.3.1 Approach

The LCFU test set will be assigned to the fleet site, NAS North Island, for a period of 6 months. Data will be acquired through the completion of Tables 2 and 3.

3.3.2 Instructions for Completing Tables 2 and 3

1. Operational Data

- **Date:** Indicate dates the coolant filtration system was used (month and day). List each batch separately, even if they occur on the same day.
- **Time/Task:** Record the start and stop time for completing one purification cycle through the LCFU (with fluid returning to the LCS).
- **Aircraft BUNO/Site:** Indicate the aircraft bureau number of the aircraft being serviced.
- **Coolant Type:** Indicate whether the coolant treated was Coolanol, PAO, or a mixture of the two.
- **Particle Count:** Indicate sample results before and after treatment.
- **Moisture Content:** Indicate sample results before and after treatment.
- **Accepted:** Indicate whether coolant can be reused based on the test results.
- **Volume Serviced:** Indicate the total volume of coolant serviced in a given batch.

- **Waste Volume:** Indicate the volume of coolant disposed of as hazardous waste.

2. Consumables

- **Date:** Indicate the date consumables were ordered.
- **Item:** Record the item number, if known, and provide a brief description of the consumables ordered.
- **Quantity/Volume:** Indicate the quantity or volume of any consumables ordered (e.g., rags, filters, virgin coolant, etc.).
- **Cost:** Indicate the cost of the consumables ordered.

3. Downtime/Month

- **Time Period:** Record periods when the coolant filtration system was not in use.
- **Reason:** Explain whether downtime was due to repairs, maintenance, workload, or other factors.

4. Repairs

- **Time:** Indicate the time required to repair the system.
- **Parts:** List the repair parts required.
- **Cost:** Record the cost of parts and the labor required for repair.

5. Qualitative Assessment: Provide a narrative evaluation of the capabilities of the coolant filtration system. Briefly discuss:

- efficiency and cost-effectiveness of the unit
- ease-of-use and the unit's ability to successfully interface with site operations
- time of operation and maintainability
- mechanical and electrical interfaces to the SUT.

4.0 REPORTING

The data entry forms are a concise method of data collection. Forms should be completed daily. Data will be collected for 6 months. During this time, periodic status reports on the testing will be submitted to NAWCADLKE. The final report will include detailed results

and observations, assess the efficiency and cost-effectiveness of the unit, and evaluate its ability to interface with site operations. Recommendations for fleetwide implementation will be based on operator input and data.



Figure 1. The Liquid Coolant Filtration Unit (LCFU)

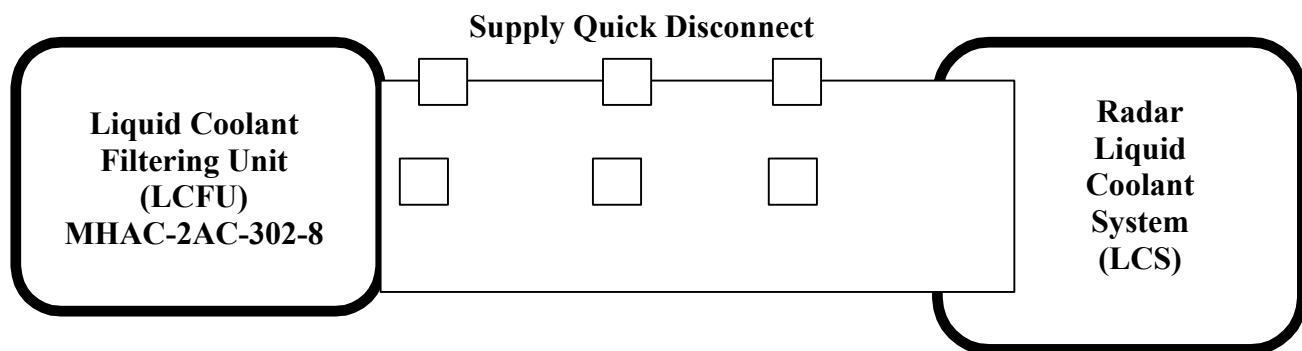


Figure 2. LCFU Process

TABLE 1

1. Checklist for LCFU and F/A-18 radar system compatibility

- 2.
- | | Yes | No |
|--|-----|-----|
| • Proper quick disconnect | ___ | ___ |
| • Pressure range (<i>required psi</i>) | ___ | ___ |

1. LCFU coolant compatibility/LCFU reconditioning effectiveness

- a. Sample Data: PAO or Coolanol
- Volume of fluid required by test _____
- Volume of fluid required by LCFU _____
- Volume/weight of water added (if applicable) _____
- Weight of particulate added (if applicable) _____

b. NOAP test results

	Sample Description	Actual Time Taken	Particulate Class	Water (ppm)	Flash Point	Volume Resistivity	Dielectric Strength
A1	Initial Coolant 1						
A2	Initial Coolant 2						
A3	Initial Coolant 3						
B1	Contaminated Coolant						
1	15 minutes operation						
2	30 minutes operation						
3	1 hour operation						
4	2 hour operation						
5	3 hour operation						
6	6 hour operation						
7	9 hour operation						
8	12 hour operation						
9	18 hour operation						
10	24 hour operation						

- a. Pre-/Post-Test Inspection: Indicate remarks on any damage found. (Attach photos if applicable.)

TABLE 2
OPERATIONAL DATA

Date	Time/Task		Aircraft BUNO/Site	Coolant Type	Particle Count		Moisture Content		Accepted	Volume Serviced	Waste Volume
	Start	Stop			Before	After	Before	After			

TABLE 3

Consumables

Date	Item		Quantity/Volume	Cost
	Number	Description		

Downtime

Time Period		Reason
Start Date	End Date	

Repairs

Date Entered for Repair	Date Repaired	Cost	
		Parts	Labor

Qualitative Assessment*:

Please comment on the effectiveness and efficiency of the unit.

* Attach additional sheet if needed.

